Online Safety Training for Factory Workers: A Usability Study

Chris Haines
University of Hawaii at Manoa
USA
chaines@hawaii.edu

Abstract: In addition to the obvious food safety requirements, manufacturing—specifically distilling—can be inherently hazardous, especially when it involves heavy equipment and highly flammable and explosive materials. Ensuring workers' safety and understanding about working in a hazardous environment is essential. While there is not necessarily a need for e-learning specifically, there is certainly a need for training. Training requirements can be extensive, and at a busy factory it can be difficult to manage, deliver, and track this training. This study explored e-learning solutions as they can be applied to needs of this industry. The purpose of this usability study was to develop and evaluate the ease of use of an online learning module designed to deliver and track safety training. The researcher designed the prototype training module, incorporating the principles of instructional design and multimedia learning. Three rounds of usability testing were conducted. Revisions were made to the prototype after each round of testing, based on user feedback to improve the user experience. User feedback indicated that simpler was better. Appealing visuals, clear and concise text, a clean layout, and prominent straightforward instructions were preferred by users. This paper discusses study results including methods, participant data, design implications, and website modifications. The study helped to provide a user-friendly online training tool that can be further developed and implemented in a workplace safety program outside the scope of this project.

Introduction

In addition to the obvious food safety requirements, manufacturing—specifically distilling—can be inherently hazardous, especially when it involves heavy equipment and highly flammable and explosive materials. While there isn't necessarily a need for e-learning specifically, there is certainly a need for training. I wanted to explore e-learning solutions as they can be applied to needs of this industry. This usability study is about developing and testing an asynchronous e-learning tool used to conduct safety training and certification through a competency-based learning approach.

At the distillery where I work, we have to comply with a lot of regulations, including those set by the Food and Drug Administration (FDA) and the Occupational Safety and Health Administration (OSHA). Much of these regulations have to do with safety, and along with physical requirements, there are many required subjects for training. In

addition to regulatory compliance, it is also important for everyone at the factory to understand how to work safely and to notice when things are unsafe.

While most of this training can be conducted in-house, it can be difficult to schedule and track everyone's progress. Other solutions are sending people to off-site classes which is costly and takes people away from their work, or bringing in expensive instructors to conduct training at our facility. In this study, I have explored the use of an online instructional module to conduct this training on location at the factory.

This research is important because it could not only lead to an easier to use and more time and cost effective training program, but because of the subject matter, it could actually improve the safety of people in a potentially hazardous workplace. If this is the case, the modules used in this study could be used to create many more, to further cover both practical and regulatory requirements, and could be a helpful tool for other organizations as well as mine.

The purpose of this usability study is to test the ease of use of a web-based asynchronous instructional module that delivers and tracks safety training for factory workers at a small distillery. The primary research questions addressed are: How easy was it for the users to navigate and find which training courses are available in the training program? How easy was it for the users to determine which training has been completed and which has been assigned to them? How easy was it for the users to select and open an assigned course? How easy was it for the student users to complete a course?

Literature Review

While researching existing training options and exploring various learning methods well suited for safety training, I determined that competency-based learning would be ideal for this subject matter, because it is learner-focused and well-suited for both independent study and concrete skills like the ones we need for safety (Soares, 2012). Competency-based learning has also been shown to reduce both training time and costs (Mendenhall, 2012), which are both important factors to consider in a business environment. Because of the competency-based approach, learners would ideally have the opportunity to "test out" of each module by completing the assessment first. Satisfactory demonstration of each competency will allow the learner to skip the tutorial content and move onto the next module. Competency-based learning was found to be suitable enough for training specific skills that Southern New Hampshire University built their new associate's degree program around that approach (LeBlanc, 2013).

It may seem obvious, but training a workforce on safety topics tends to improve safety conditions within the workplace. A study of the construction industry the USA found a decrease in injuries and fatalities after an OSHA-mandated training program was placed into effect (Taylor, 2014). Another study, conducted in Canada, of various forms of occupational health and safety training, found them to effective in improving conditions

within the workplaces studied (IWS, 2017). As for the delivery of such content, an IWS impact study in 2013 found online training to be effective method for safety topics.

The focus of this study was to improve the delivery of training in a factory setting. An online training tool should improve this as long as the tool is functional and easy for the learners and administrators to use. This is important as current methods can be tedious, inconvenient, and difficult to track. Usability is a well-known and widely-addressed issue in marketing and design, but can be overlooked in educational tools, despite its importance and the difference a user-centric design approach can make in the effectiveness of learning tools (Clayton, 2011). Krug (2014), explains how thinking about usability from the beginning of a project and incorporating the concepts into the design process can improve outcomes and save both time and money. Central Carolina Community College used this approach to redesign all of their web resources to be more user-centric, and which now provide a better overall user experience for both students and faculty (Dishman, 2015).

Rather than continue old methods of gathering workers together and lecturing them all on a topic that many may already be familiar with which can be redundant and a waste of time, an online tool that is competency-based would allow individual workers to log in and access just the training that they need and to demonstrate their knowledge of familiar topics without attending redundant lectures.

Project Design

The participants in this study were nine factory workers of a wide range of ages. All were fluent in English although it was a second language for some. The participants' skill and frequency of computer use also varied, but was average to below average. These factors all needed to be taken into consideration for the design and development of the training module. The module had to be easy to use for people who do not frequently use computers—especially for work. Language was not a huge issue, but making sure to keep the instructions and content simple and uncomplicated was important to make sure that everyone could understand and more importantly, learn from this training tool.

Keeping in mind Steve Krug's (2014) first law of usability, I wanted to make the usage obvious and self explanatory. I also drew from Richard Mayer's (2005) principles for the design of multimedia learning, including the multimedia principle: that people learn better from both words and images than from words alone; the segmenting principle: that people learn better when lessons are presented in learner-paced segments rather than as a continuous unit; and the coherence principle: that people learn better when extraneous material is excluded.

Delivery of the course content was in an asynchronous format. Essential content was broken down into individual competencies based on (OSHA) safety standards and requirements, as published in the Code of Federal Regulations (CFR). All course content and learning objectives (competencies) were be designed around these regulations, and

were be delivered through the Canvas learning management system (LMS). Canvas LMS was selected for a few reasons. It is free to use, it is relatively user-friendly for both the learner and the designer as compared to a few other options that were explored, and because I was already somewhat familiar with it from using it in a few of my previous courses in the LTEC program. Also, Canvas is extremely feature rich, and can be added to with many extra features and plugins.

Most the course content consisted of online tutorials with text diagrams and/or videos for each competency, followed by text-based quizzes. Assessments were designed with the goal of certifying the learner in the demonstrated competencies, as required by CFR standards. Each competency had an associated quiz administered through the LMS. Content for the courses was be derived from OSHA (2017) documentation and publications as well as from existing resources provided by Instructional Designs, Inc. (2017).

Other considerations for the development of the training modules included timing and workflows. The training had to be able to be completed around a participant's work schedule, allowing them to learn without being a major interruption to their work, and to allow them to stop and continue as they needed. Also, for the purposes of this study, I wanted the participants to be able to complete a training module during the usability test. To accomplish this without the test taking way too long, both the sample lessons and the quizzes were shortened to allow the participant to complete them in a reasonable time. One way that this was done was by restricting quiz questions to just true/false and multiple choice, which are faster for the subject to answer.

To keep the learners engaged and to lighten up otherwise dry topics, humorous material was used whenever possible and without distracting from the importance of the topics. As much as possible, explanatory drawings and diagrams were utilized to illustrate concepts. Negative examples were also used, as when it comes to safety it is often important to show what not to do.

Figures 1 through 3 are screenshots showing the prototype training system that was tested in this study. Users could log in, see what training they have been assigned, and either complete the training modules or test out of them without going through the entire lesson. Appendix A through C show the observation instruments that were used for recording during the usability tests, the testing and subject interview scripts, and required consent forms.

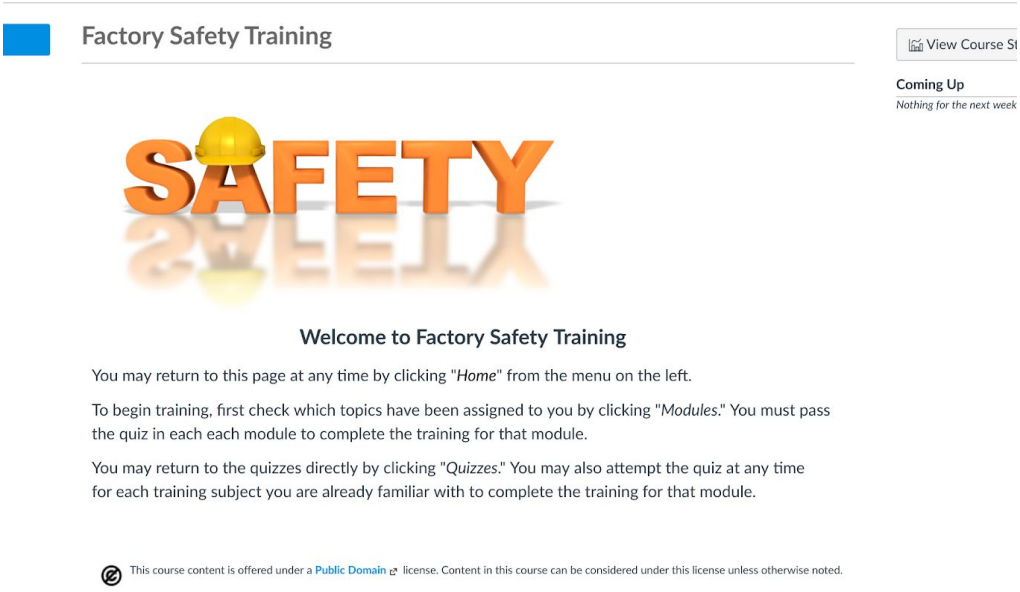

Figure 1. Prototype training home page.

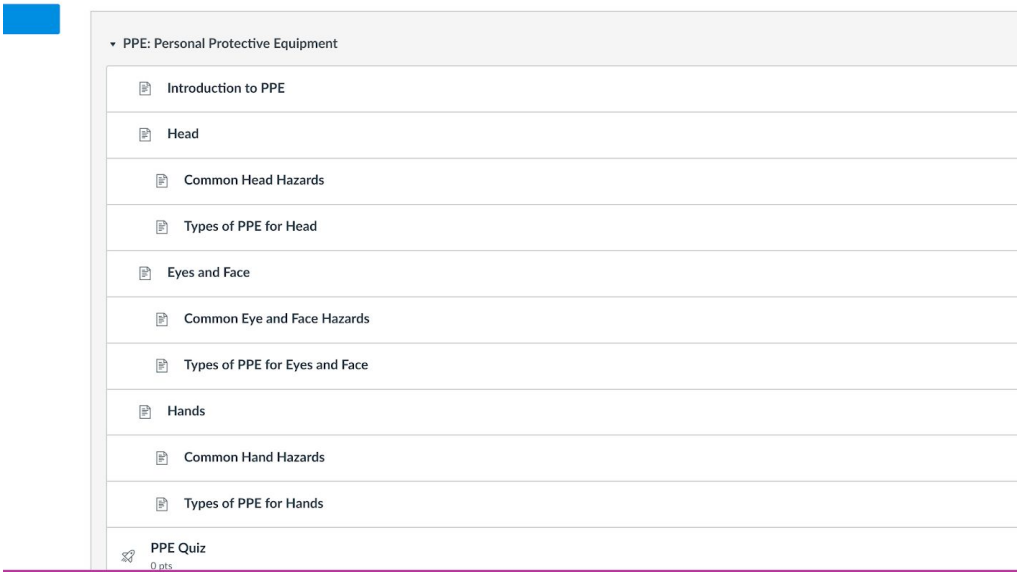

Figure 2. Prototype training module list.

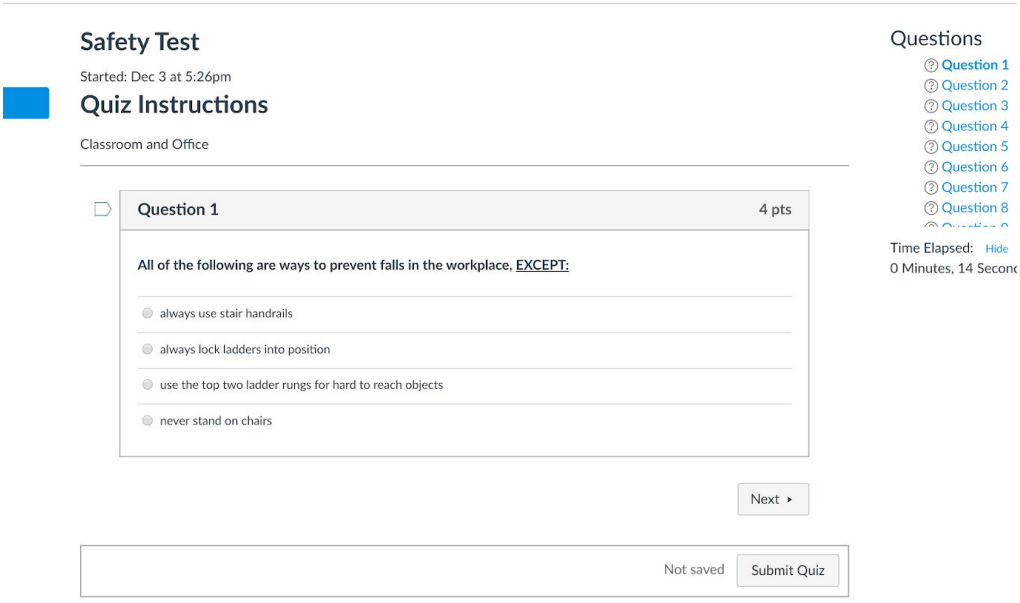

Figure 3. Prototype training module quiz.

Methods

Volunteer participants were recruited in person during January of 2018 from a pool of relevant factory workers. Once selected, they were be given instructions and a date and time was be selected to conduct the test with each of them. As all of the subjects were employees, they were informed and assured that their participation was voluntary and would not affect their employment in any way.

The usability study was designed with and was conducted in accordance with concepts from Krug's manual on usability testing (2010). To test the online training tool, learners were observed during the lessons and assessments delivered through the online training modules. Results from each round of testing were applied to revise and improve the modules for the next round. Both the training and testing features and the record-keeping aspects of the training tool were evaluated. Learners were given scenarios and tasks to complete, including both completing a training module and checking to determine which training topics are available, assigned, or already completed. Learners were also interviewed before and after completing the instructional module to serve as formative assessment.

To evaluate the ease of use of the training program, the investigator conducted usability studies in person with the subject using a provided computer workstation. Prior to the testing, the subjects were asked to read and sign a consent form. There was then a brief introductory interview to collect relevant demographic information, technical skills, online habits, and e-learning experience. After this, screen recording was turned on so that the investigator would be able to observe the subjects' onscreen activities (where do the they click, etc.) For screen recording, I used a tool called Screencastify. It is a plugin

that works with the Chrome browser, which initially worked well as the tests were conducted on a Chromebook. However, the free service ran out about halfway through testing without warning and I was not able to screen record the rest of the sessions. This was not a great loss, though, as the visual observations and interviews proved to be sufficient.

During the testing, the subjects were asked to complete four specific tasks, which helped the investigator to identify any issues with the training program. As the subjects performed the tasks, they were asked to think out loud so that their voice would be recorded along with the screen activities. After the completion of the tasks, screen recording would end and the subjects were interviewed to collect their opinions and observations on the program's design, layout, navigation, and what they liked, disliked, or would improve. This concluded the testing and data collection for each subject. The average total time spent by the subject was 30 to 45 minutes.

Krug (2010) recommends a minimum of three subjects for each round of usability testing. Three were used for each round, for three rounds. Both quantitative and qualitative data from the usability tests and interviews were analyzed to determine any usability problems. Each problem discovered was ranked by severity, and resolved in order of most severe prior to the next round of testing. Three rounds of iterative testing were sufficient to identify any significant problems and improve the usability of the training program.

Results

I have already described the participants' demographics, but I want to elaborate on a few things that appeared to make a difference in the results. More users preferred online training to face to face training, but even more had no preference. The wide age range did not make a significant difference in the results, but users having spent a greater amount of time online and having previously taken on online course did correlate slightly with improved task completion rates these are shown in figures 4 and 5.

Figure 4. Participant e-learning experience.

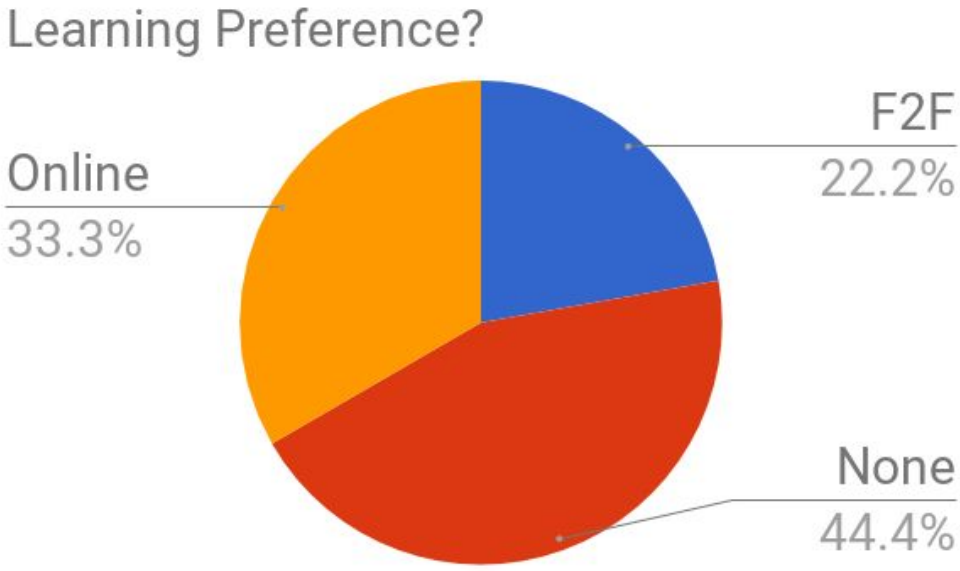

Figure 5. Participant e-learning preference.

The biggest factor that appeared to contribute to the outcomes was whether the participant read the instructions or not (figure 6). Users who did read the instructions successfully completed one more task on average than users who did not (figure 7). This was not a surprising result.

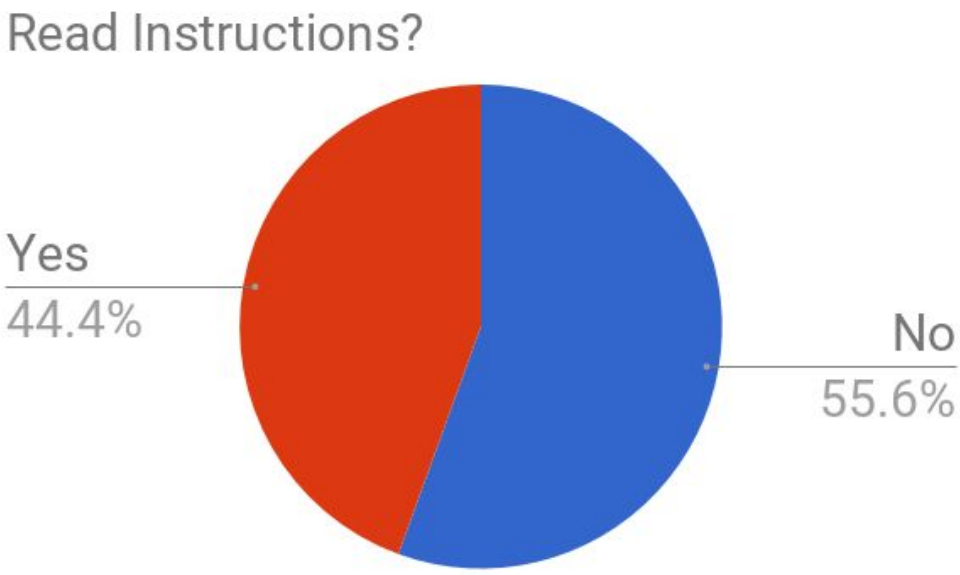

Figure 6. Did the participants read the instructions?

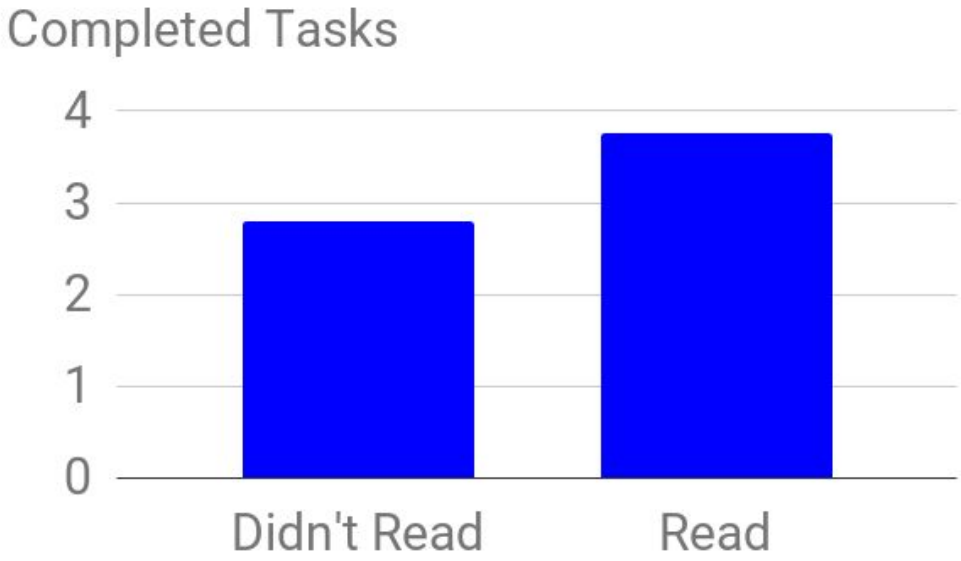

Figure 7. Task completion rates of participants that read vs did not read the instructions.

The four tasks that users were asked to complete were to find and navigate to the training modules, then to determine which training had been assigned to them, then to select a course from what was assigned, and finally to complete one of the courses. If they were unable to complete a task in a reasonable amount of time, or thought they had completed it but had not or they did it incorrectly, we moved on to the next task. The first task

proved to be most difficult, but completion rates for all tasks improved in round two after the first revisions were made (figure 8).

Figure 8. Task completion rates for each round of testing.

User-reported difficulty for each task was on a 5 point scale, with 1 being the easiest and 5 being most difficult. Most tasks were found to be a 2 or better, with each task becoming easier with each round of testing (figure 9).

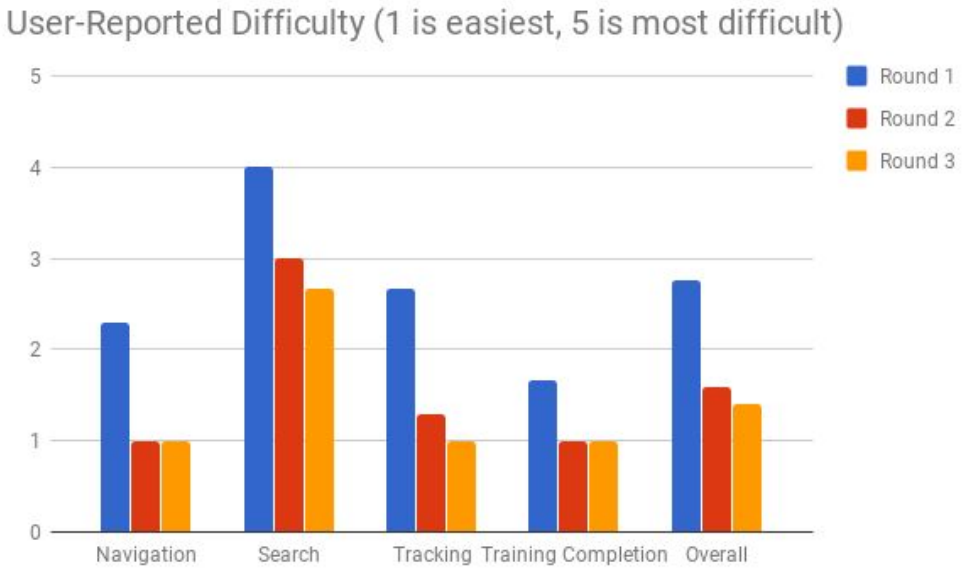

Figure 9. User reported difficulty for each task per round.

From the post testing interviews, participants liked the use of photos, drawings, and examples. They liked the clean and straightforward design, the simple and easy to follow instructions, and the humorous images used to lighten up tedious topics. Most interesting was the fact that many reported that they prefered learning at their own pace and were more comfortable with the individual online training than they were learning in a group setting. Some of the improvements that participants suggested were to add “primer” questions or pre-tests to beginning of modules, to vary quiz questions from a larger bank of available questions rather than repeat the same ones every time, to add a progress bar to the modules and clearer indications for completed modules, and to add a chat or discussion feature. All users found the training site to effective overall, and recommended that similar training be implemented in their workplace.

Most of the issues and problems participants found with the training had to do with getting started, navigating the modules, the instructions, and the Canvas platform itself. There were some issues with images loading slowly, and even taking so long to load the user was done reading the page before the image loaded. This was addressed by reducing the image size as much as possible without sacrificing visual quality.

The navigation menu was initially made as minimal as possible to prevent confusion. However, because of the way the tasks were written, some users were getting lost looking for their “assignments.” So I added an Assignments link to the navigation menu, and that reduced the problem going forward.

It was also found that users were also skipping the introduction and instructions and just jumping right in. This resulted in them getting lost and not knowing how to recover. A bold red “start here” notice was added to the front page, and while it helped a little, it was still ignored by a few participants.

Based on user feedback, emphasis was added to the navigational text within the instructions, as well as making them into functional links to allow users to click them directly as an alternative to the navigation menu. This helped for some, but also added a new issue of users clicking them before they were done reading, and then ending up lost again. Revisions are shown in figure 10.

Figure 10. Revisions from the first round of testing.

After round two, issues with instructions were addressed again. It was discovered that one of the biggest problems was the Canvas platform itself. Participants were not familiar with the platform and had some trouble with the concept of the training module being a separate course within the overall Canvas platform. Basically the modules and Canvas were two new things to learn at once, and this contributed to some confusion. A couple of users even accidentally left the training course and got lost within the greater Canvas environment. To attempt to improve this, the instructions were clarified and an "intro to Canvas" video was embedded on the first page (figure 11). This did not really help, however, because no one watched it.

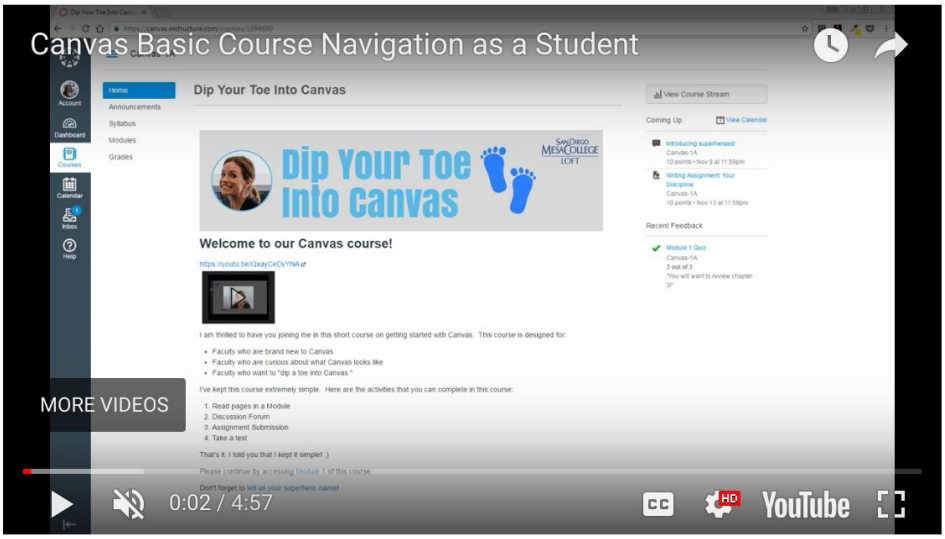

Figure 11. Revisions from the second round of testing.

Discussion and Conclusions

In conclusion, all participants found the training site to be useful and usable overall. Several usability issues were identified in testing, which were addressed as well as could be done within the scope of the project. Most participants preferred the training website over their current training methods, and all recommended the implementation of online training for their workplace safety program. Considering that the biggest issue was a lack of familiarity with the online tools used in the study, this issue could be easily resolved in practice by an introductory session that showed the users how to use the online training before they got started.

This research is important because it can not only lead to an easier to use and more time and cost effective training program, but because of the highly important subject matter, it could actually improve the safety of people in a potentially hazardous workplace. The modules developed for and used in this study could be used to create many more, to further cover both practical and regulatory requirements, and could be a helpful tool for other organizations as well as mine. Looking to the future, this training tool could definitely be a viable training tool for us at the factory. If something like this were to be implemented, we might explore utilizing some of the paid features and plugins for Canvas, or even using alternative or standalone platforms. We could create company-specific content for even better engagement with the learners, and if we came up with something really good, we could also consider selling it for other companies to use.

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APPENDIX A
Consent Form

University of Hawai'i
Consent to Participate in a Research Project
Grace Lin, Principal Investigator, and Chris Haines, Student Investigator
Project title: Online Safety Training Usability Study

Aloha! My name is Chris Haines and you are invited to take part in a research study. I am a graduate student at the University of Hawai'i at Mānoa in the College of Education. As part of the requirements for earning my graduate degree, I am conducting a usability study. The purpose of this usability study is to test the ease of use of a web-based asynchronous instructional module that delivers and tracks safety training to factory workers like you.

Activities and Time Commitment: If you participate in this project, the usability study will take place in the safety office and will take approximately 20 to 30 minutes. The session will begin with a brief pre-survey, followed by the study in which you will navigate and use an online training tool to complete a series of tasks. With your permission, audio will be recorded during this time so that I will be able to review your comments and feedback. The study will conclude with a post-survey and a brief interview. You will be among 9 to 15 people participating in this study.

Benefits and Risks: There will be no direct benefit to you for participating in this interview. The results of this project may help improve the company's training program and participating employees. I believe there is little risk to you for participating in this research project. In the event that you become stressed or uncomfortable answering any of the questions or discussing topics with me during the interview, you can also stop the interview or withdraw from the project altogether.

Privacy and Confidentiality: I will keep all study data secure in a locked filing cabinet in a locked office/encrypted on a password protected computer. Only my University of Hawai'i advisor and I will have access to the information. Other agencies that have legal permission have the right to review research records. The University of Hawai'i Human Studies Program has the right to review research records for this study.

After I transcribe the interviews, I will delete the audio-recordings. When I report the results of my research project, I will not use your name. I will not use any other personal identifying information that can identify you. I will use pseudonyms (fake names) and report my findings in a way that protects your privacy and confidentiality to the extent allowed by law.

Voluntary Participation: Your participation in this project is completely voluntary. You may stop participating at any time. If you choose to stop participating in the study, there will be no penalty or loss to you. Your choice to participate or not participate will not affect your position in the company.

Questions: If you have any questions about this study, please call or email me at 808.312.9567 or chaines@hawaii.edu. You may also contact my advisor, Dr. Grace Lin, by email at gracelin@hawaii.edu. You may contact the UH Human Studies Program at 808.956.5007 or uhirb@hawaii.edu. to discuss problems, concerns and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research protocol. Please visit https://www.hawaii.edu/researchcompliance/information-research-participants for more information on your rights as a research participant.

University of Hawai'i
Consent to Participate in a Research Project
Grace Lin, Principal Investigator, and Chris Haines, Student Investigator
Project title: Online Safety Training Usability Study

If you agree to participate in this project, please sign and date this signature page and return it to me.

Keep a copy of this informed consent form for your records and reference.

Signature(s) for Consent:

I give permission to join the research project entitled, "*Safety Training Usability Study*"

Please initial next to either "Yes" or "No" to the following:

____ Yes ____ No I consent to be audio-recorded for the interview portion of this research.

Name of Participant (Print): _____

Participant's Signature: _____

Signature of the Person Obtaining Consent: _____

Date: _____

Mahalo!

APPENDIX B
Usability Protocol and Script

Facilitator Script

Hi, [say participant's name]. My name is Chris, and I'm going to be walking you through this session today.

Before we begin, I have some information for you, and I'm going to read it to make sure that I cover everything.

The first thing I want to make clear right away is that we're testing the *website*, not you. You can't do anything wrong here. In fact, this is probably the one place today where you don't have to worry about making mistakes.

As you use the site, I'm going to ask you as much as possible to try to think out loud: to say what you're looking at, what you're trying to do, and what you're thinking. This might feel strange, but will be a big help to us.

Also, please don't worry that you're going to hurt our feelings. We're doing this to improve the site, so we need to hear your honest reactions.

If you have any questions as we go along, just ask them. I may not be able to answer them right away since we're interested in how people do when they don't have someone who can help. But if you still have any questions when we're done I'll try to answer them then.

And if you need to take a break at any point, just let me know. Do you have any questions so far?

- ❑ ***Ask participant a few preliminary questions:***

OK. Before we look at the site, I'd like to ask you just a few quick questions about your experience as an online student.

1. Have you done any online training or classes before?

2. If so, how many?

3. If you have taken online classes or training, did you prefer it to more traditional classroom or face-to-face training?

4. Why or why not?

5. Now, roughly how many hours a week altogether—just a ballpark estimate— would you say you spend using the Internet, including Web browsing, email, and anything else?

6. What kinds of sites are you looking at when you browse the Web?

7. Have you ever built or helped edit a website?

8. If so, what program or software did you use?

OK, great. We're done with the questions, and we can start testing out the site.

- ❑ ***Begin the screen recording***

Ask participant to open URL.

- ❑ ***Have the participant load the training website***

- ❑ ***Have participants do a narrative of the website's overall appearance:***

I'm going to ask you to look at this page and tell me what you make of it: what strikes you about it, whose site you think it is, what you can do here, and what it's for. Just look around and do a little narrative. You can scroll if you want to, but don't click on anything yet.

- ❑ ***Ask participant to complete a few specific tasks based off of their scenarios sheet:***

Thanks for doing that. You did a great job. Now I'm going to ask you to try doing some specific tasks. I'm going to read each one out loud.

We are done with the main questions, but I have a few more general questions to ask you.

1. If you found issue with an aspect of the site, would you rate it 1- Minor, 2-Moderate, or 3-Critical? Do you have any insights on how the problem can be fixed?
2. On a scale of 1 to 7, with 1 representing very difficult and 7 representing very easy, how would you rate your experience during today's testing?
3. Please think back to other online courses you have taken before. Have you ever needed to perform tasks like the ones you did in the usability test today? Compared to your prior experience, would you say that the tasks you performed today were easier or more difficult? Why?
4. After participating in this study, would you recommend this course to any of your friends? Why?

That's the last question, Do you have any questions for me, now that we're done?

I want to thank you for your time and willingness to be a participant in this study.

APPENDIX C
Observation Sheet

Usability Study Interview and Observation Sheet

User #: _____ Test date: _____ Start time: _____ Ending time: _____ Version: _____

☐ Check this box if the consent form has been signed.

Preliminary Interview

1. Have you done any online training or classes before? Yes No

2. If so, how many? _____

3. If you have taken online classes or training, did you prefer it to more traditional classroom or face-to-face training? Yes No

4. Why or why not?

_____
_____
_____
_____

5. Now, roughly how many hours a week altogether—just a ballpark estimate—would you say you spend using the Internet, including Web browsing, email, and anything else? _____

6. What kinds of sites are you looking at when you browse the Web?

_____
_____
_____

Initial Impressions

Navigating the website homepage: What do you notice first? What strikes you about it?

_____
_____
_____
_____

What are your initial impressions about the layout and what do you think of it visually (colors, graphics, photos, etc.)?

_____
_____
_____
_____

What are your thoughts of the text on this page?

_____
_____
_____
_____

Whom is it for? What makes you think so?

_____
_____

What do you think people can do on this website? How can you tell so?

_____
_____

If allowed to click something on this homepage, where would you click first?

_____
_____

Other comments

_____
_____
_____
_____

Tasks

Task #1: Find out what training courses are available

_____
_____
_____
_____
_____
_____

Duration to complete the task: _____ (min)

Task difficulty: EASY 1 2 3 4 5 HARD

Why?

_____
_____
_____
_____
_____

Suggested improvements?

_____
_____
_____
_____
_____

Other comments

_____
_____
_____
_____
_____
_____

Tasks

Task #2: Determine which training has been completed and which course(s) has been assigned

_____
_____
_____
_____
_____
_____

Duration to complete the task: _____ (min)

Task difficulty: EASY 1 2 3 4 5 HARD

Why?

_____
_____
_____
_____
_____

Suggested improvements?

_____
_____
_____
_____
_____

Other comments

_____
_____
_____
_____
_____
_____

Tasks

Task #3: Select and open an assigned training course

_____
_____
_____
_____
_____
_____

Duration to complete the task: _____ (min)

Task difficulty: EASY 1 2 3 4 5 HARD

Why?

_____
_____
_____
_____
_____

Suggested improvements?

_____
_____
_____
_____
_____

Other comments

_____
_____
_____
_____
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_____

Tasks

Task #4: Complete the selected course

_____
_____
_____
_____
_____
_____

Duration to complete the task: _____ (min)

Task difficulty: EASY 1 2 3 4 5 HARD

Why?

_____
_____
_____
_____
_____

Suggested improvements?

_____
_____
_____
_____
_____

Other comments

_____
_____
_____
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_____

General Questions

1. If you found an issue with an aspect of the site, would you rate it: 1- Minor, 2-Moderate, or 3-Critical?

2. Do you have any insights on how the problem can be fixed?

_____
_____
_____
_____

3. On a scale of 1 to 5, with 1 representing very easy and 5 representing very difficult, how would you rate your experience during today's testing? EASY 1 2 3 4 5 HARD

4. Please think back to other online courses you have taken before. Have you ever needed to perform tasks like the ones you did in the usability test today? Yes No N/A

5. Compared to your prior experience, would you say that the tasks you performed today were *easier* or *more difficult*?

6. Why?

_____
_____
_____
_____

7. After participating in this study, would you recommend this training website? Yes No

8. Why?

_____
_____
_____
_____

6. Do you have any suggestions to improve the website? Any likes, dislikes, or other comments?

_____
_____
_____
_____
_____
_____